



## SWAC 4 Oceanography and Energy Propagation

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### SWAC 4 Propagation Analysis

**Objective:**

Characterize the acoustic conditions in Kiparissiakos Bay, 12 May 1996, during the SWAC 4 sea test

**Conclusion:**

Region 1: The entire water column is ensonified to a high level. Spherical and cylindrical spreading are the dominant loss mechanisms.

Region 2: In this region, the sound speed profile controls energy distribution. High energy is trapped in a narrow ducted path and at caustics.

### SWAC 4 Propagation Analysis

**Approach:** Estimate the acoustic energy propagation using two oceanographic models:

1. Comprehensive Acoustic Simulation System (CASS)  
Vertical view of acoustic propagation for a single bearing angle, i.e. (variable range and depth)
2. Active Sensor Performance Model (ASPM)  
Horizontal view of acoustic propagation for a single depth, i.e. (variable range and bearing)

## SWAC 4 Analysis Focus

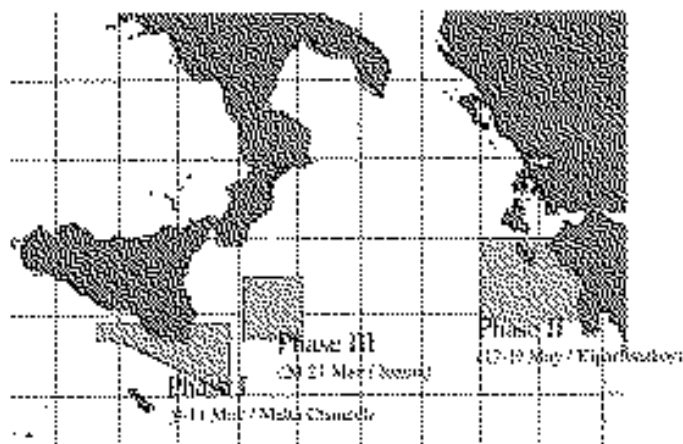
Runs 9 and 10 were chosen based on the estimated time the whales beached<sup>1</sup> (morning to early afternoon of 12 May 1996). Parameters are given in the following table.

Local Time is GMT (Greenwich Mean Time) + 3 hours

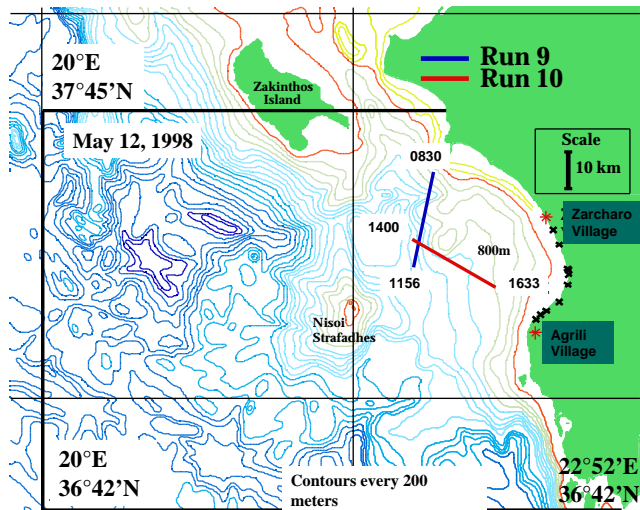
Run	Date	Start hh:mm Local	Finish hh:mm Local	NRV Alliance Speed(kts)	TVDS Depth(m)	MFTA Depth(m)	LFTA Depth(m)	Total Pings
Run 9	May 12	08:30	11:56	5	82-72	76-69	77 -86	208
Run 10	May 12	14:00	16:33	5	72	69	77-83	157

(1) Scientific Correspondence: "Does Acoustic Testing Strand Whales?," A. Frantzis, Nature (magazine), 5 March 1998.

Three SWAC 4  
Operational Areas

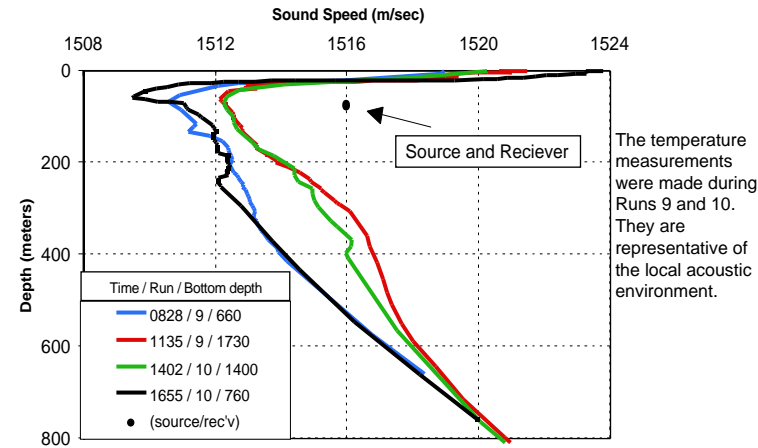


SWAC 4 Events Examined



locations from: "Mass Stranding of *Ziphius cavirostris* in Greece," 12 May 1996. <http://whales.magna.com.au/News/Ziphius.html>

SWAC 4  
Sound Speed Profiles



SWAC4  
Waterbourne Energy

Sound Energy Level (SEL) at any point in the ocean is a result of the energy the source transmits over the bandwidth and pulse length of the waveform used, less the losses incurred by spreading in the media and other attenuating factors.

For the CW signals sent during Phase II, we have:

$$\text{SEL} = \text{SL} + 10 \text{ Log (pulse length)} - \text{TL}$$

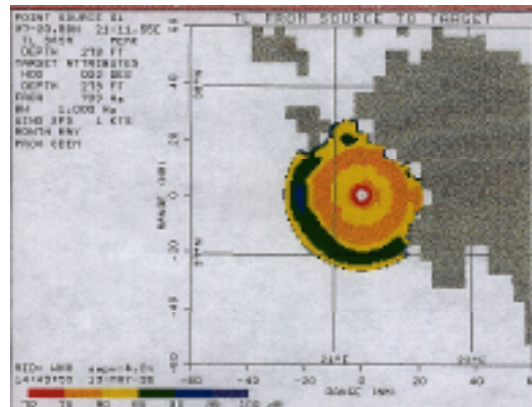
$$\text{SEL}_{700 \text{ Hz}} = 226 + 3 - \text{TL} = 229 - \text{TL} \quad 2 \text{ second CW}$$

$$\text{SEL}_{3300 \text{ Hz}} = 223 + 3 - \text{TL} = 226 - \text{TL} \quad 2 \text{ second CW}$$

Note: these numbers represent the case where maximum energy is transmitted.

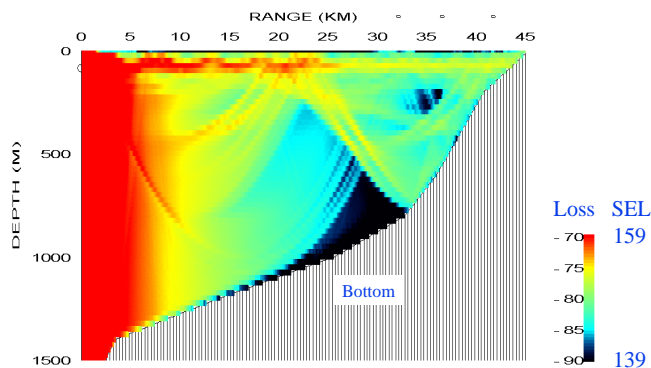
### SWAC 4 Low Frequency Propagation Loss, Horizontal View

Freq  
700Hz  
Source  
Depth 85m  
Target  
Depth 85m

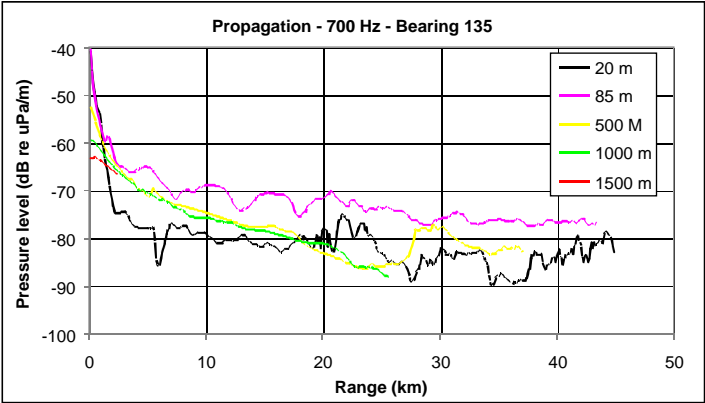
SWAC4 Low Frequency  
Propagation Loss, Vertical View

Model: CASS

Realistic SSP-B; Low Loss  
700 Hz; Source 85 M; Bearing 135 deg

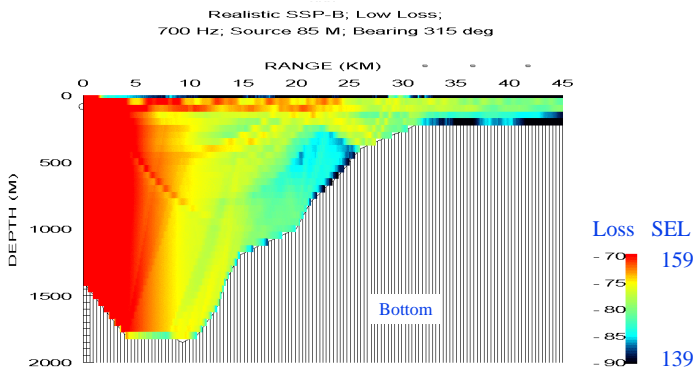


SWAC 4 Low Frequency  
Propagation Loss at Five Depths  
*(data as in previous CASS slide)*

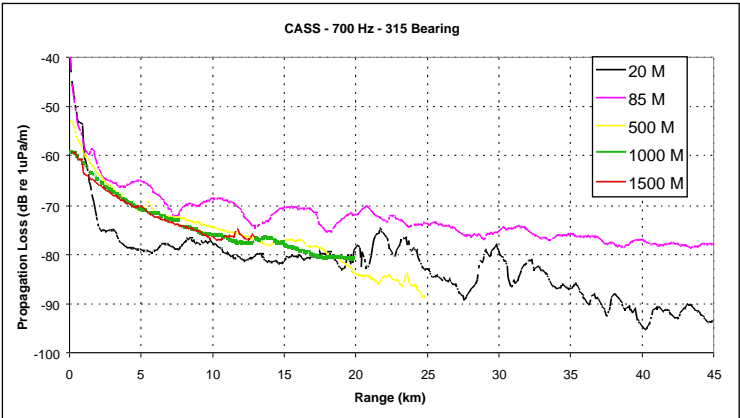


SWAC4 Low Frequency  
Propagation Loss, Vertical View

Model: CASS

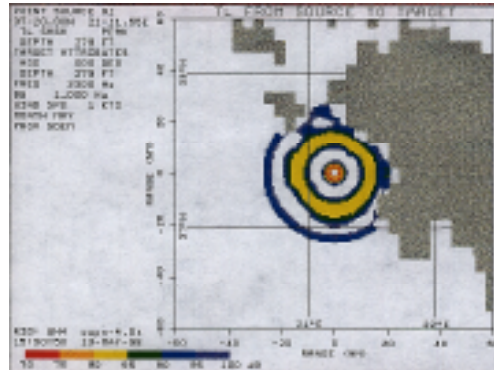


SWAC 4 Low Frequency  
Propagation Loss at Five Depths  
*(data as in previous CASS slide)*



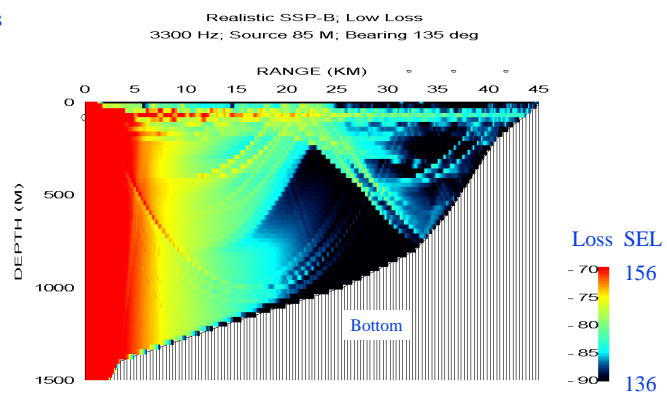
## SWAC 4 Mid Frequency Propagation Loss, Horizontal View

Freq  
700Hz  
Source  
Depth 85m  
Target  
Depth 85m



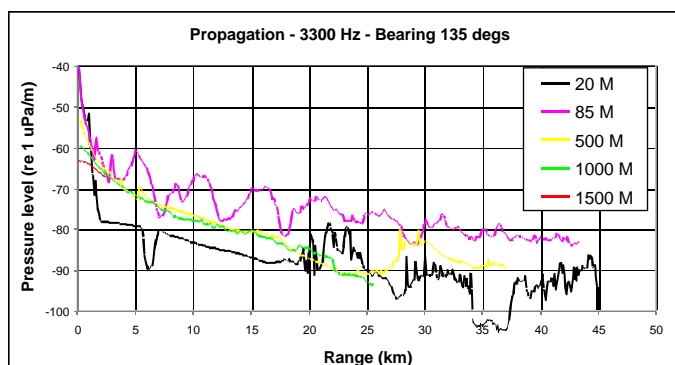
## SWAC4 Mid Frequency Propagation Loss, Vertical View

Model :CASS



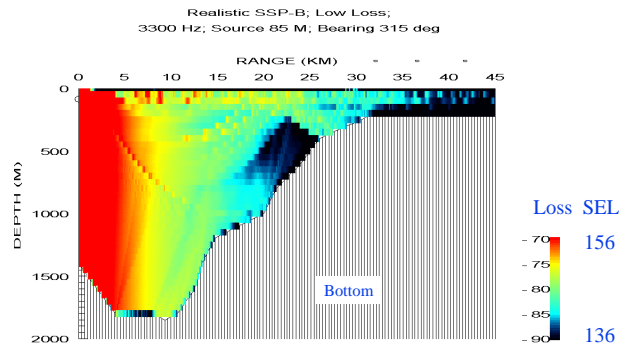
## SWAC 4 Mid Frequency Propagation Loss at Five Depths

(data as in previous CASS slide)



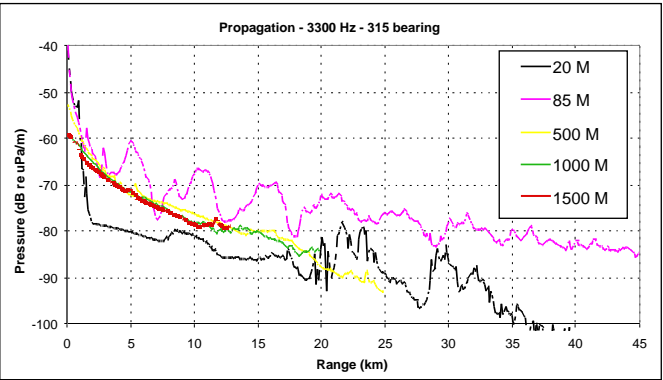
# SWAC4 Mid Frequency Propagation Loss, Vertical View

Model: CASS



# SWAC 4 Mid Frequency Propagation Loss at Five Depths

(data as in previous CASS slide)



## Oceanography and Energy Propagation Summary

Two models were exercised and agree on the area's general propagation picture. At both Low and Mid Frequencies, and for all directions about the source, two distinct propagation regions develop.

Region 1: The entire water column is ensonified to a high level. Spherical and cylindrical spreading are the dominant loss mechanisms.

Region 2: In this region, the sound speed profile controls energy distribution. High energy is trapped in a narrow ducted path and at caustics.

## Oceanography and Energy Propagation Summary

- No unusual activity observed at sea, Real-Time Display Operators Logs and Run Comments Logs reviewed. LF and MF Display Contact Logs note high shipping noise, but no unusual contacts.
- Temperature measurements were regularly made (to the bottom) from the NRV Alliance. These were used for real time propagation predictions using C-SNAP.

## Oceanographic Models Used

**CASS** (Comprehensive Acoustic Simulation System) a fast running, range dependent, ray based system performance model. CASS offers a vertical slice product that is used here to illustrate energy propagation.

### ASPM (Active Sensor Performance Model)

A range-dependent performance model which computes TL, arrival time, time spread, reverberation density and echo for active systems in monostatic and bistatic configurations. ASPM offers a horizontal slice view that is used to illustrate energy propagation.

Both models can input the source and receiver beampatterns and neither model incorporates the effects of sub-bottom factors.